

**COHORT: An Integrated Information Approach to Decision Support for  
Military Subpopulation Health Care**

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## **Abstract**

Delayed recognition and response to health syndromes in the past have highlighted the critical need for real-time surveillance of the health status of forces as an enabling capability for decision makers. Real-time surveillance serves to alert health authorities and make possible rapid, appropriate, and effective responses to limit the adverse impact of occupational and operational threats to health.

In support of Force Health Protection, the USAF Surgeon General has recognized a need for early detection of syndromes and epidemics in specific cohorts (subpopulations) over time. Cohort surveillance and monitoring require analytical tools and access to pertinent, timely, and consolidated medical data.

The Composite Occupational Health and Operational Risk Tracking system (COHORT) addresses the USAF Surgeon General's need by providing real-time surveillance of the medical care and treatment of specified groups of military personnel across multiple medical health facilities throughout the world. The medical encounter data aggregated by COHORT provide input for timely detection and monitoring of occupational health concerns and disease trends, syndromes, and outbreaks. The early detection made possible by COHORT avails key decision makers the opportunity to formulate appropriate responses in time to make a difference in the outcome.

## **1. Introduction**

The health and fitness of military personnel are key concerns of those responsible for ensuring troop readiness and effectiveness. Delayed recognition and response to health syndromes in the past have highlighted the critical need for real-time surveillance of the health status of forces as an enabling capability for decision makers. Real-time surveillance serves as a "canary" to alert health authorities and make possible rapid, appropriate, and effective responses to limit the adverse impact of occupational and operational threats to health.

The acknowledged importance of Force Health Protection has resulted in several legal and administrative initiatives through public law, memorandums, instructions, and directives to provide procedures for conducting health surveillance in support of force health protection. These include.

- **Public Law 105-85, Section 765 (18 November 1997)** – This law mandates medical surveillance of all service members before, during, and after military deployments. As defined by the Centers for Disease Control and Prevention, health surveillance is the ongoing, systematic collection, analysis, and interpretation of health data essential to planning, implementing, and evaluating public health practice.
- **Under Secretary of Defense (P&R) Memo on Enhanced Post-Deployment Health Assessments (22 April 2003)** – This memorandum directs enhancements to post-deployment health assessments, including an expanded questionnaire and

face-to-face assessment with a health provider, blood samples for all returning personnel, placing deployment health information in the permanent medical record, and ensuring appropriate follow-up medical care.

- **Department of Defense Instruction 6490.3 (7 August 1997)** – This instruction implements the policy, prescribes procedures, and assigns responsibility for joint military medical surveillance in support of deployments.
- **Department of Defense Directive 6490.2 (30 August 1997)** – This directive establishes the policy for routine joint medical surveillance of all military members during deployments.

In support of Force Health Protection, the United States Air Force (USAF) Surgeon General is tasked with the care of Air Force personnel and their families and the protection of their health. The USAF Surgeon General has recognized a need for early detection of syndromes and epidemics or significant deviations from expected levels in medical data in specific cohorts (subpopulations) over time. Cohort surveillance and monitoring require analytical tools and access to pertinent, timely, and consolidated medical data.

## **2. Vision**

The Composite Occupational Health & Operational Risk Tracking system (COHORT) vision is to enable the USAF Surgeon General to consolidate, extract, and make available medical data from various military health care facilities for the analysis and early detection of epidemics, disease trends, and health anomalies and in support of cohort monitoring.

Cohort monitoring falls into two categories: prospective and retrospective. A prospective cohort study is an epidemiological study in which a group of people is identified who are at risk for experiencing a particular event. A retrospective cohort study is an epidemiological study in which a group of people is identified who have experienced a particular event.

Sample sizes for cohort studies often must be very large, particularly if only a small portion of the overall population will experience a particular event. The entire group must be followed over time to determine the point at which an event occurs, variables associated with the event, and outcomes for those who experienced the event compared with those who did not.

COHORT addresses the USAF Surgeon General's need by providing real-time surveillance of the medical care and treatment of specified groups of military personnel across multiple medical health facilities throughout the world. The medical encounter data aggregated by COHORT provide input for timely detection and monitoring of occupational health concerns and disease trends, syndromes, and outbreaks. The early

detection made possible by COHORT avails key decision makers the opportunity to formulate appropriate responses in time to make a difference in the outcome.

COHORT leverages existing normalized clinical data available from operational decentralized Integrated Clinical Database (ICDB) sites. Locally deployed ICDB systems support the Military Health System (MHS) health care providers who deliver clinical services to all enrolled members of the military health care community. As entries and updates are made on the local ICDB system, a software agent transmits the new or updated medical data to the centralized COHORT database. In effect, the data are made available to COHORT at the same time the data is made available to the local health care provider.

COHORT can monitor the incoming ICDB data traffic continually, processing the data against user-defined business rules to detect deviations from user-specified thresholds. COHORT provides the ability to send automated alerts to appropriate staff notifying them of events (cases, clusters, or signals) that warrant investigation. In addition, COHORT maintains a repository of the data in a reporting database to support analysis through state-of-the-art online analytical processing (OLAP) software.

COHORT will enable the USAF Surgeon General to consolidate, monitor, extract, and make available medical data from various military health care facilities for the analysis and early detection of epidemics, disease trends, and health anomalies. In support of Force Health Protection, COHORT will achieve the following objectives:

- **Consolidates ICDB Data** – COHORT extracts pertinent medical data sets from decentralized ICDB locations and consolidates the data on a centralized database. These data include laboratory results, prescriptions, radiology results, procedures, diagnoses, and immunizations.
- **Avails ICDB Data to Analytical Engines** – COHORT provides access to the consolidated medical data to facilitate cohort monitoring, real-time detection and surveillance, and long-term analysis.
- **Monitors, Alerts, and Disseminates** – COHORT issues alerts and disseminates monitoring results based on defined alert criteria and signal thresholds.
- **Supports Online Reporting and Analysis** – COHORT will provide a web interface for the viewing of reports and ad-hoc analysis of data.

### **3. Approach**

In support of force health protection, the USAF Surgeon General has identified a potential capability to effectively extract, aggregate, and synthesize medical data from the various decentralized Integrated Clinical Database (ICDB) sites for the early identification and analysis of infectious disease trends and anomalies. Early recognition of these medical events will provide critical information for timely and appropriate

response.

The ICDB system supports local Military Health System (MHS) health care providers who deliver and track appropriate and timely clinical services on all enrolled members of the military health care community. ICDB provides operational users the capabilities to retrieve, maintain, analyze, display, and print timely and accurate clinical services data. ICDB is either currently deployed or scheduled to be deployed in support of over 80 military health care facilities throughout the world.

USAF has a unique opportunity and ability to leverage the investment made in the existing ICDB systems to support force health protection via real time alerts and cohort monitoring. The COHORT Oracle application server provides the ability to send automated alerts to appropriate staff notifying them of events (cases, clusters, or signals) that warrant investigation. A subset of the interactive channels used for sending the alert messages are: PDA, Web, email, and Telephony. When integrated with commercial off-the-shelf (COTS) or custom analytical tools, epidemiologists can use the aggregated data for long-term research, monitoring, surveillance and analysis. For example:

- The magnitude and distribution of the outbreak
- Time, location, and mode of exposure
- Demographics of affected persons
- Vehicle(s) of exposure
- Persons at risk for disease (from either initial exposure or secondarily through contact with a case) who will need treatment, prophylaxis, and medical follow-up.

#### **4. Objectives**

COHORT will leverage existing capabilities of ICDB to support the following objectives:

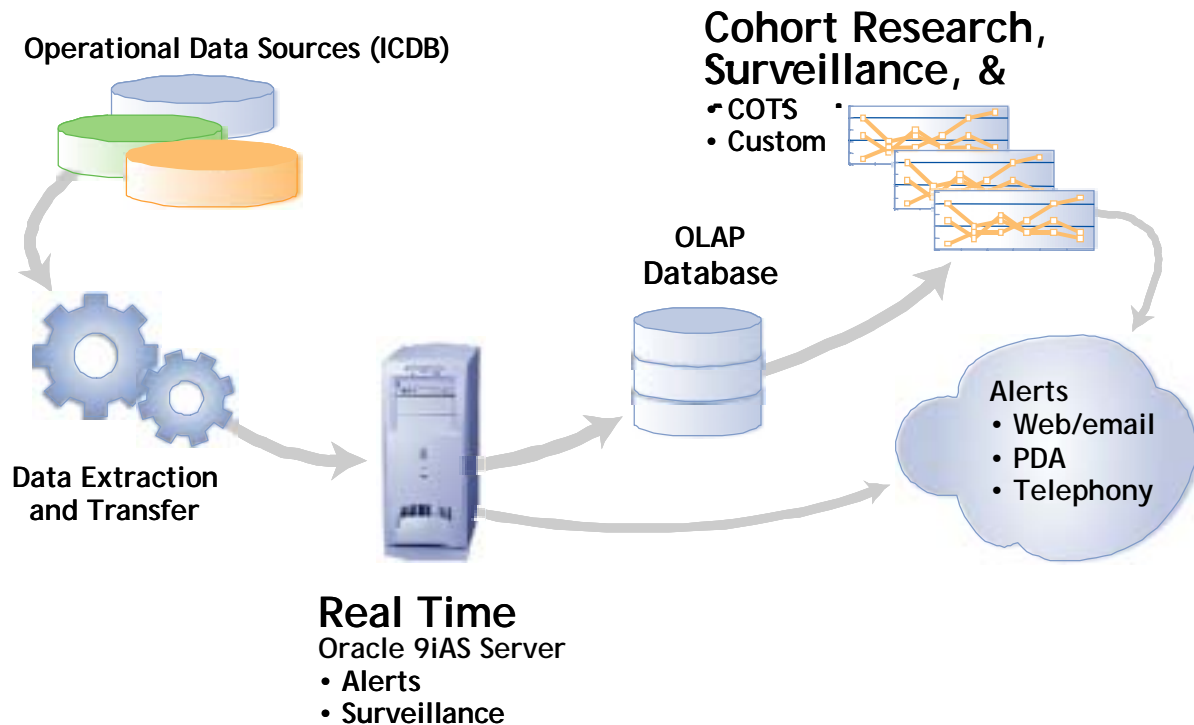
**Consolidate ICDB Data** – COHORT will extract pertinent medical data sets from decentralized ICDB locations and consolidate the data on a centralized database. These data may include laboratory results, prescriptions, radiology results, procedures, diagnoses, and immunizations.

**Avail ICDB Data to Analytical Engines** – COHORT will provide access to the consolidated medical data to facilitate cohort monitoring, real-time detection and surveillance, and long-term analysis.

**Monitoring, Alerting, and Dissemination** – COHORT will provide alerts and dissemination of monitoring results based on defined alert criteria and thresholds.

**Support Online Reporting and Analysis** – COHORT will provide a web interface for the viewing of reports and ad-hoc analysis of data.

Figure 1: Micro COHORT Collection Overview



COHORT will provide the following capabilities when integrated with analytical tools and algorithms:

- Cohort monitoring and analysis
- Detection of reportable diseases and syndromes
- Process control charts to detect clusters and changes in trends
- Alerts to staff
- Fully accessible, cumulative data set for research or special studies

## 5. Industry Benchmark

COHORT will leverage software systems and solutions that have been built for industries that face similar challenges and needs. Analogous systems include financial trading and

analysis systems and healthcare decision support systems. These system types support monitoring, alerting, and dissemination and research of trends, incidences, and patterns for decision support.

## 6. Technology Solution

COHORT will be built using standard technologies with a proven history of solving complex problems in a scalable, flexible, maintainable, and architecturally sound way.

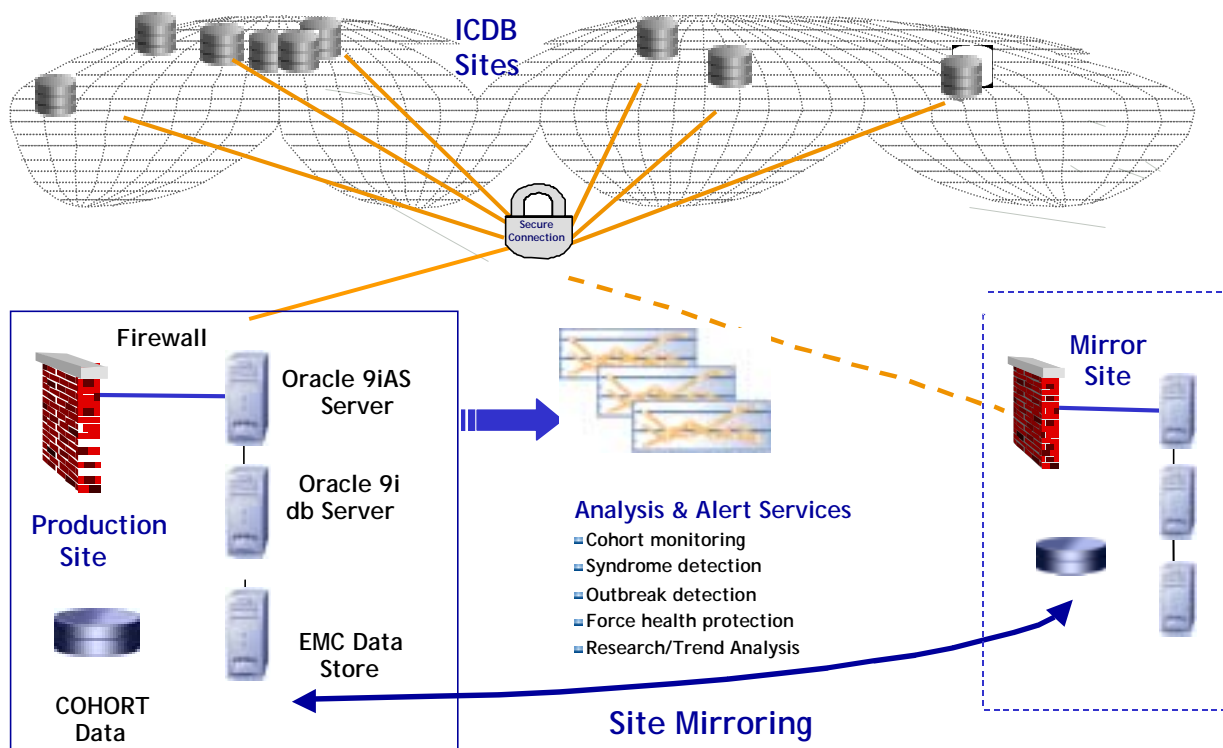
### *Java/J2EE*

Java 2 Enterprise Edition (J2EE) is the programming architecture of choice for server-side development of enterprise-class applications. Developers can take advantage of the many third-party offerings of Java packages, database drivers, and vendor-specific application adapters, as well as develop their own custom applications.

### *Oracle 9i Database Server*

Oracle 9i provides a robust database platform for scalable, flexible, data-intensive application development. Oracle has many important features that make it not only an exceptional database management system, but also an excellent database server choice for enterprise computing.

Figure 2: Macro COHORT Collection Overview





## *Oracle 9i Application Server*

Oracle 9i AS is a fully-featured, standards-based J2EE application server providing the core application development environment. With its comprehensive set of features, compliance with open standards, multi-tiered architecture, and support for component-based development, businesses are choosing Oracle 9i AS to develop and deploy best-of-breed applications.

COHORT will use Oracle 9i AS to provide:

- Secure Data Transfer Interface
- Real Time Data Monitoring and Alerts
- Web Interface for Reporting and Analysis
- The Oracle application server will be deployed on Windows 2000 Advanced Server.

### **Secure Data Transfer Interface**

To facilitate the use of data from multiple sources, the application will use an adapter-based architecture. This will allow data transfer agents to communicate to the application via a standard set of encrypted XML formats and protocols. Additional data feeds can be added by creating data agents for that particular source without requiring changes to application code.

XML Data Transfer Formats:

- Real Time Data Sets
- Aggregated Data Sets
- Historical Data

Transfer from data agents will use the XML-RPC web services protocol over certificate-based secure socket layer (SSL). The Oracle server provides all the required web services protocols and security mechanisms to accomplish these transfers.

### **Real Time Data Monitoring and Alerts**

Real time data monitoring can be accomplished using many tools available in Java for the Oracle platform. These tools include:

- Statistical analysis and modeling

- Ilog – Jrules Rules Engine Financial modeling and alerting
- Scientific analysis packages
- Online Analysis and Processing

Algorithms and tools developed in other programming languages are easily integrated into the J2EE platform via standard connection protocols and services (JNI, SOAP, XML-RPC).

Alerts will utilize a standard Java Messaging Service (JMS) protocol to hook into any number of available alert providers. By using JMS adapters for alerting services any number of services can be used with no change to the application code.

#### *Web Interface for Reporting and Analysis*

Oracle is ideally suited for developing and deploying web applications for reporting and data analysis. Several COTS products are available for online analysis, expert systems reporting, and query capability:

- FormulaOne - e.Report
- Visual Mining inc. – Net Charts
- Custom designed web interfaces

#### *ICDB Data Agent*

The ICDB Data Agent will leverage existing ICDB infrastructure by running as a Java service on the ICDB Interface server. This agent will periodically check for data that needs to be extracted from the operational data store, transform that data into a standard XML packet, and transmit it via SSL to the main COHORT application server over XML-RPC. This data transfer can be done as often as required to ensure timely data for processing on the Oracle server.

#### *OLAP Interface and Tools*

The Oracle 9i provides standard interfaces for OLAP and other analysis tools to work directly on the data. These interfaces allow complex queries to be run directly against the data for research and analysis.

Oracle Data Mining (ODM) incorporates supervised and unsupervised learning models. Supervised learning models, sometimes called directed models, are used to predict a value, or probability. These techniques are appropriate for scenarios where you identify a dependent variable and want to model how a group of independent variables influence it.

### *Data Storage, Mirroring and Replication*

EMC DAS/SAN solutions provide an ideal environment for the intense demands of today's networked storage environments, offering industry-leading performance, high availability, simple management, and unparalleled consolidation for Windows and UNIX. EMC provides expandable storage for the growing dataset needed to facilitate surveillance and detection.

The EMC storage arrays can be used for several purposes. The most basic use for the array is to provide the multi-terabyte database storage required by the application. In addition, EMC MirrorView and SnapView software can be used for:

- Site Mirroring for Disaster Recovery and Fault Tolerance
- Data Replication to other database instances for Research and Reporting to other locations or for performance reasons.

## **7. Summary**

Currently, the United States Air Force (USAF) Surgeon General (SG) has a mission to provide Force Health Protection for active duty Air Force personnel and their dependents. Past successes indicate that cohort analysis – the analysis of small linked sub-populations - is a timely and cost effective mechanism for early detection and warning of possible health risks to a larger population. Cohort surveillance and monitoring requires analytical tools and access to pertinent, timely, and consolidated medical data. However, The USAF SG does not have a viable integrated medical surveillance system to adequately execute that mission. This shortfall limits health care administrators the ability to issue timely and effective direction and guidance. There are a number of reasons for that shortfall – but many of the reasons have solutions that can be found through the integration of existing and emerging information technology (IT) programs.

The technologies required to address this shortfall are a combination of commercial-off-the-shelf and government-off-the-shelf (COTS/GOTS) solutions. By integrating these tools and in some cases adding specific enhancements/extensions, COHORT can provide USAF decision makers with real-time data and analysis on the medical health of the military population. COHORT addresses the USAF Surgeon General's need by providing real-time surveillance of the medical care and treatment of specific groups of military personnel across multiple medical health facilities throughout the United States as well as those deployed overseas.

COHORT will enable the USAF Surgeon General to consolidate, monitor, extract, and make available medical data from various military health care facilities for the analysis and early detection of epidemics, disease trends, and health anomalies. Medical surveillance and monitoring provide decision makers necessary and paramount information needed for the appropriate deployment of personnel and assets. Through such an analytical tool as COHORT, Command and Control (C2) leaders are empowered

to; accurately ensure the safety of a specific location, determine appropriate resources required to combat specific disease trends and adverse health care outcomes and provide an accurate assessment of the health of target populations. The result for C2 management is fewer casualties – civilian and military, decreased recurrence of diseases, less waste in treatment options and an overall healthier and fit fighting force.

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# ***Headquarters U.S. Air Force***

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## ***COHORT:***

***An Integrated Approach to Decision Support for  
Military Subpopulation Health Care***



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Assistant Surgeon General  
Modernization Directorate, AF/SGR**

**U.S. AIR FORCE**

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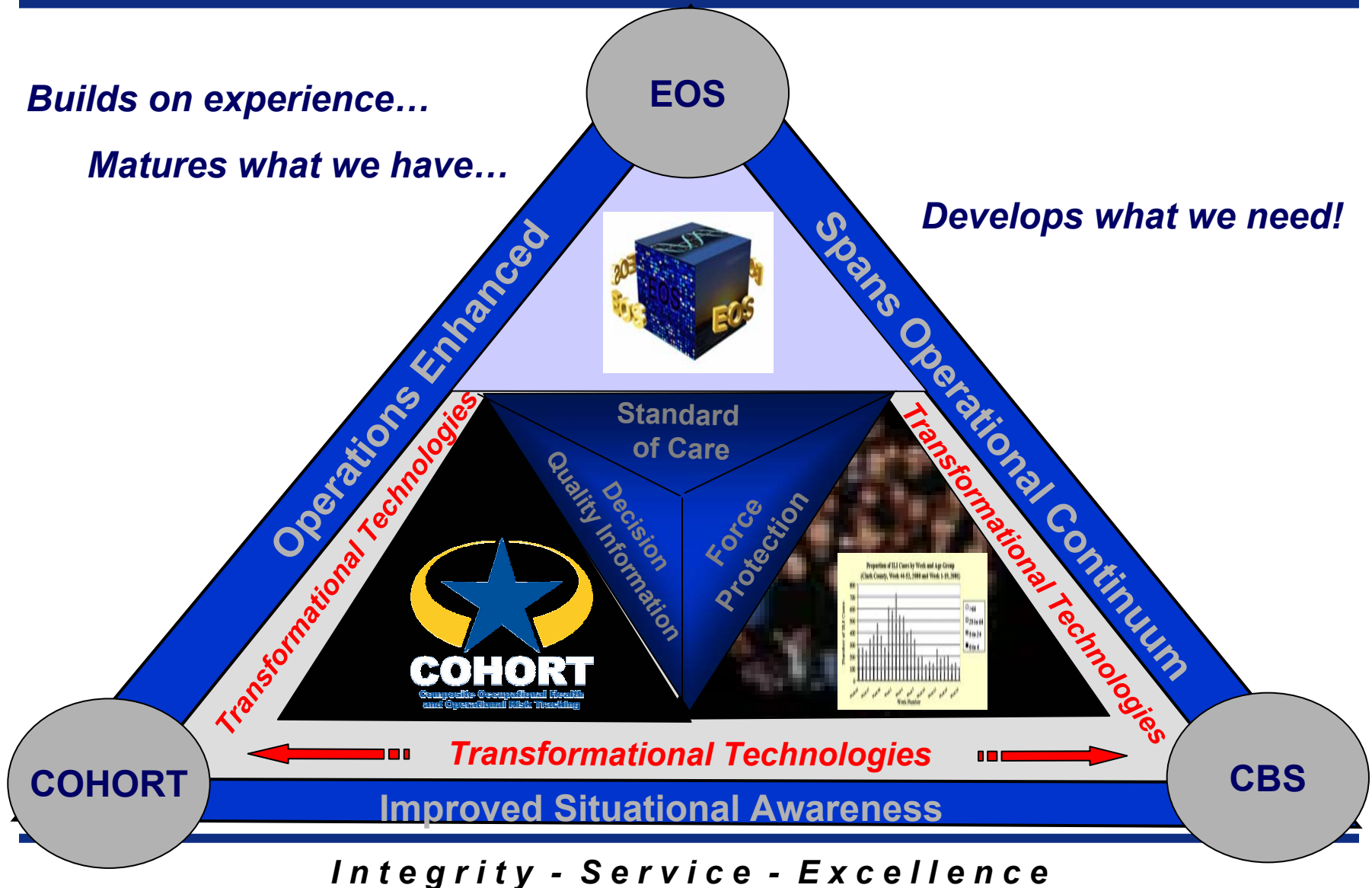
# Transformation...



*Builds on experience...*

*Matures what we have...*

*Develops what we need!*





# COHORT

**Composite Occupational Health  
and Operational Risk Tracking**



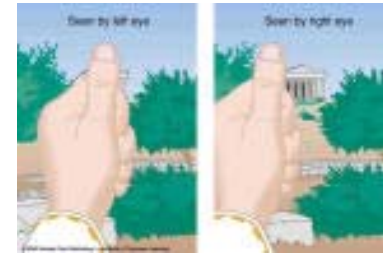


**U.S. AIR FORCE**

# Overview



- **What is COHORT?**
- **What is Parallax?**
  - **Why COHORT is different.**
- **Does it Work?**
  - **A Case Study.**
- **How did we do it?**
- **Other applications in medical research.**



*par-al-lax (p r -l ks )n.*

- 1. The apparent displacement of an object caused by a change in the position from which it is viewed.*
- 2. (Astron.) The apparent difference in position of a body (as the sun, or a star) as seen from some point on the earth's surface, and as seen from some other conventional point, as the earth's center or the sun.*



**U.S. AIR FORCE**

# ***What is COHORT?***



- **Composite Occupational Health & Operational Risk Tracking**
  - **A series of relevant database that have been consolidated into a datamart that allow for the continuous monitoring, analysis and early detection of epidemics, disease trends, and health anomalies among and across an infinite selection of cohorts though a variety of data applications**
  - **Provides temporal and geographic medical surveillance of every Air Force member from induction through retirement**

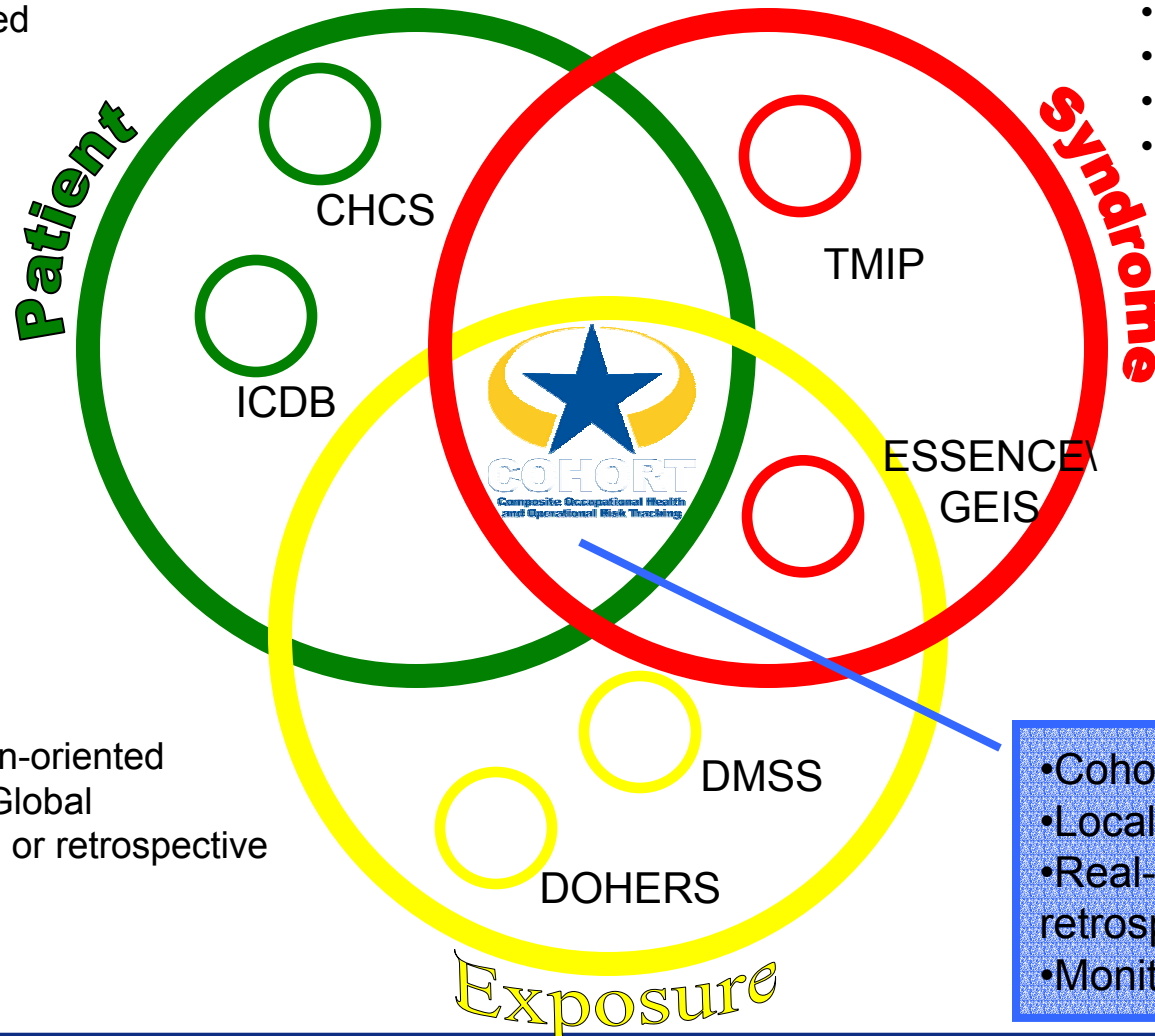


U.S. AIR FORCE

# Parallax to Surveillance Perspectives



- Patient-oriented
- Local
- Real-time



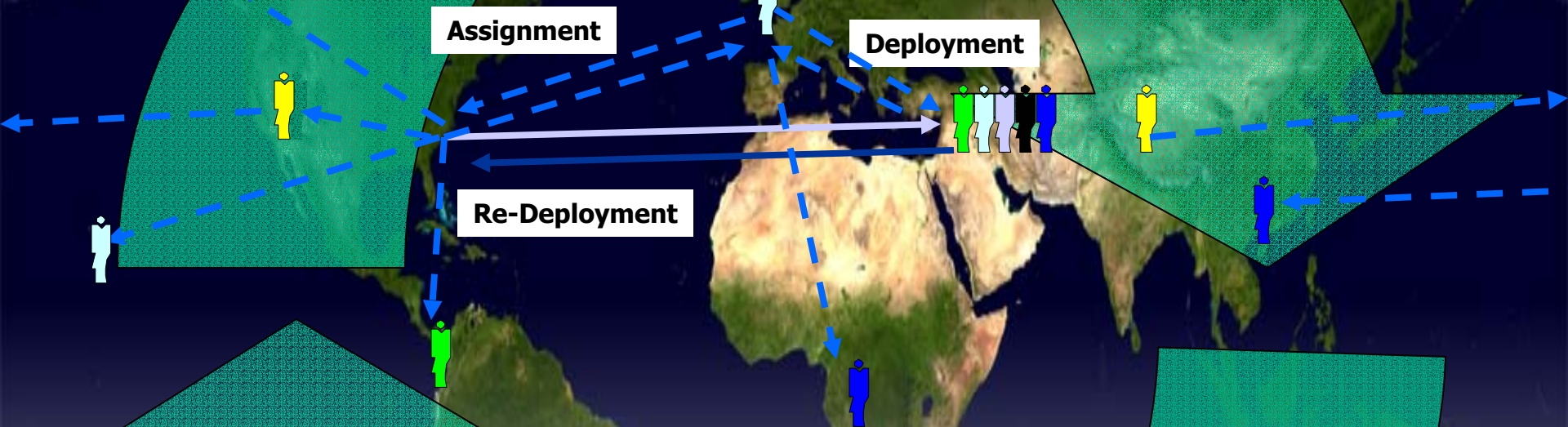
- Disease-oriented
- Local or Global
- Real-time
- Retrospective

- Population-oriented
- Local or Global
- Real-time or retrospective

- Cohort-oriented
- Local or Global
- Real-time or retrospective
- Monitor ANY Cohort

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# Operational



# Occupational



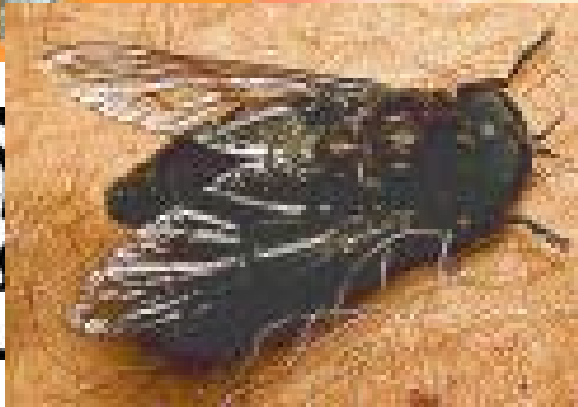
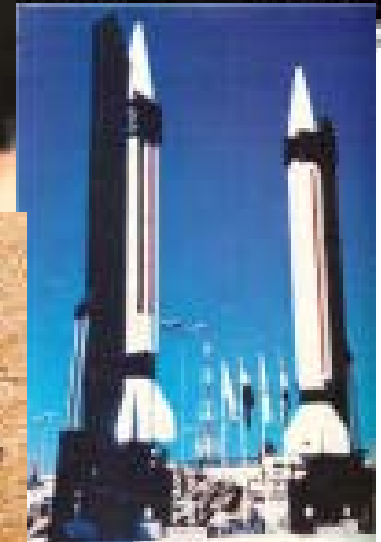
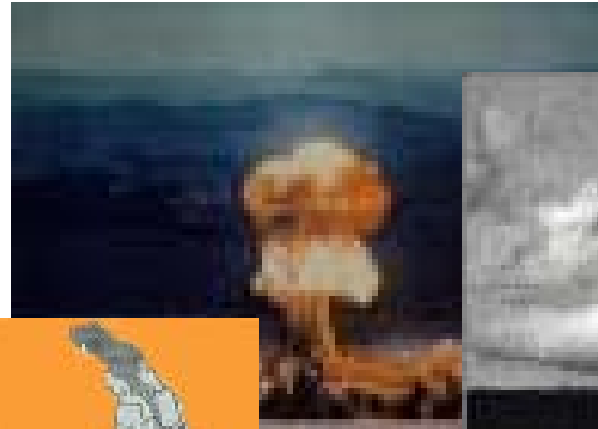


**U.S. AIR FORCE**

# ***Troop Exposure***



- **Exposure to Nuclear Testing**
- **Agent Orange**
- **Gulf War Syndrome?**
- **Operation Iraqi Freedom?**
- **Occupational Hazards**
  - **Noise**
  - **Chemical**
  - **Work Injury**
  - **Directed Energy**



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# COHORT Case Study



## How Do We Know The Data Are Accurate?

“... Since 2002, military health officials have reported 22 cases of the disease, with the majority being reported ...”

- Tyndall AFB, Florida, Gulf Defender, Vol. 62, No 41, Oct 24, 2003

Oct. 24, 2003

Gulf Defender Page 5

### AF halts certain blood donations

ARMY SGT, 1ST CLASS BORG SAMPLE  
American Forces Press Service

**WASHINGTON (AFPN)** — A parasitic disease being spread by sand flies in Iraq has prompted officials who oversee the military's blood supply to implement a one-year donor deferral for military people serving in that country.

The reason for the deferral is a form of the disease Leishmaniasis which causes sores or lesions on the skin, and which in its most serious form can cause death. Since 2002, military health officials have reported 22 cases of the disease, with the majority being reported this year.

"It's a cautious deferral, we're erring on the side of safety," said Lt. Col. Ruth Sylvester, director of the Army's blood program office. "People who actually get the disease are permanently deferred," she explained. "The issue with those who are exposed is that there is an incubation period before any symptoms appear — the deferral will prevent them from unknowingly donating (infected) blood."

According to blood program officials, the parasite that causes the disease has been proven to survive in blood

products stored under standard conditions for up to 25 days. At least six transfusion-transmitted cases of the disease have been reported.

Colonel Sylvester, who said she is not a physician but understands the disease, said there are two types of Leishmaniasis. The most common, but less serious, form is cutaneous Leishmaniasis, which causes lesions on the skin that may look like a volcano with a raised edge and center "crater" and may be covered with a scab, she said.

"All of the military cases so far have been cutaneous," she added. However, she said the more serious form of the disease, visceral Leishmaniasis, can affect the internal organs of the body, such as the spleen and liver, and can lead to death.

Colonel Sylvester said military people who have been infected with the disease are being treated at Walter Reed Army Medical Center here, where doctors have set up a special-treatment program just for the disease. People infected with the disease undergo a three-week drug regimen that "will eliminate the disease and take care of the infection," she said.

"I don't believe there is cause for alarm," Colonel Sylvester said. "We had 22 cases in the last two years with all the people we've had deployed in Afghanistan and Iraq throughout the entire Central Command area. So it's a very small number, given the total number of people deployed."

But she did express concern about the disease's impact on the number of eligible military blood donors. The latest deferral is just one of many the military's blood program is now facing, she said.

In recent years, blood-program officials had to defer donors because of malaria risks worldwide. They also had to defer people who might (have) been exposed to a variant of Creutzfeldt-Jakob disease, better known as "mad cow" disease, or who lived in certain parts of Europe for specified time periods between 1980 and 1996.

"When we lose these donors, we have to bring in more donors," Colonel Sylvester said. "We have to find donors who have not traveled, not been deployed, and haven't lived in Europe. It's imperative that we find donors who have not been deployed, and we're focusing our efforts on bringing those donors in."

Colonel Sylvester said the military has plenty of eligible donors to draw from, and she encouraged military and Department of Defense employees, as well as family members, to donate blood on a regular basis by scheduling appointments with local DOD donor centers. Where the DOD does not have donor centers, she encourages donations to local civilian agencies.

"In the DOD blood program, we only touch a very small percentage of the population that we draw from — about 20 percent of the eligible donors," she said. "So there are plenty of donors out there. The (challenge are) to get them in the door and to get them to donate."

Peacetime MAJCOM	Peacetime Installation	Career Field	Gender	# Coded Diagnoses
AF Special Operations Command (0V)	MOODY	12 (Navigator)	M	91
Air Combat Command (1C)	EGLIN	2E (Communications Electronics Systems)	M	37
Air Combat Command (1C)	EGLIN	3E (Civil-Engineering)	M	28
Air Combat Command (1C)	ELLSWORTH	3M (Services)	M	28
Air Education and Training Command (0J)	LUKE	2G (Logistics Plans)	F	28
US Air Force Europe (0D)	SPANGDAHLEM	1C (Command Control Systems Operations)	M	28
AF Materiel Command (1M)	WRIGHT PATTERSON	3A (Information Management)	M	28
Air Mobility Command (1L)	ANDREWS	2T (Transportation and Vehicle Maintenance)	M	21
Air Mobility Command (1L)	CHARLESTON	2A (Manned Aerospace Maintenance)	M	14
US Air Force Europe (0D)	LIVORNO	2W (Munitions and Weapons)	F	14
Air Mobility Command (1L)	CHARLESTON	2I (Description(?))	M	7
AF Materiel Command (1M)	EDWARDS	3P (Security Forces)	M	7
AF Element, US Central Command (3C)	MACDILL	3P (Security Forces)	M	7
AF Space Command (1S)	MALMSTROM	3M (Services)	F	7
AF Office of Special Investigations (07)	ANDREWS	3U (Manpower)	M	7
11th Wing (2W)	BOLLING	6C (Contracting)	M	7
AF Materiel Command (1M)	KIRTLAND	3P (Security Forces)	M	7
Air Education and Training Command (0J)	LACKLAND	2E (Communications Electronics Systems)	M	7
Air Combat Command (1C)	ROBINS	3A (Information Management)	F	7
AF Space Command (1S)	MALMSTROM	3A (Information Management)	F	6
AF Element, Europe (3G)	BRUNSSUM	9A (Awaiting Discharge/Retraining)	M	2
AF Space Command (1S)	MALMSTROM	5J (Paralegal)	F	1

Queries on the COHORT database match compulsory reportable incidences of occurrence



**U.S. AIR FORCE**

# Current Duty Status of Infected Cohort



Actual Cases by SSN (Masked)				
Deployment Year	Deployed Location	SSN	Deployed (Y/N)	Current Duty Location
2003	IRAQ	148*****	N	ROBINS
2003	IRAQ	233*****	N	SPANGDAH
2003	IRAQ	292*****	N	WRIGHT PAT
2003	IRAQ	300*****	N	OSAN
2003	OTHER	218*****	N	LUKE
2000	OTHER	101*****	N	OSAN
2001	OTHER	245*****	N	SCOTT
2003	OTHER	249*****	N	LACKLAND
2000	OTHER	258*****	N	CHARLEST
2002	OTHER	356*****	N	ELLSWORT
2003	OTHER	377*****	N	ANDREWS
2003	OTHER	434*****	N	EGLIN
2000	OTHER	522*****	N	MALMSTRO
2003	OTHER	530*****	N	UNK
2003	OTHER	573*****	N	MOODY
2003	OTHER	576*****	N	MACDILL
2001	OTHER	589*****	Y	CONUS
2003	OTHER	640*****	Y	OCONUS
2003	OTHER	985*****	N	UNK



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# Who Else May Be Infected?



CASE #1	
FRN	FG7WC
Deployed Country	Iraq
Deployed State	Kirkuk
# Males	10
# Females	2
Date Arrived Theater	5/7/2003 to 5/9/2003
Air Force Career Group	Operations

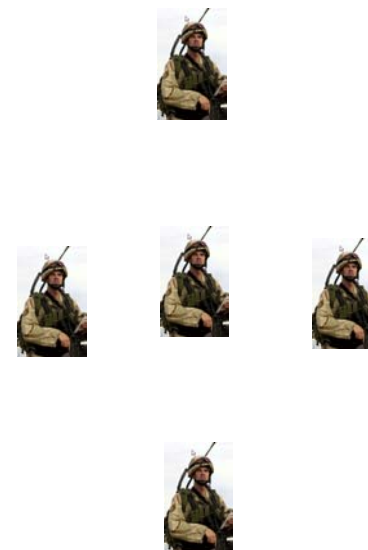
CASE #2	
FRN	AU1N3
Deployed Country	Iraq
Deployed State	Tallil
# Males	32
# Females	8
Date Arrived Theater	4/19/2003 to 4/24/2003
Air Force Career Group	Logistics and Support

CASE #3	
FRN	FW43J
Deployed Country	Iraq
Deployed State	Kirkuk
# Males	5
# Females	0
Date Arrived Theater	37730
Air Force Career Group	Support

Infected Troop



Infected Troop







U.S. AIR FORCE

# Case For Preventive Intervention?



## Leishmaniasis, US Armed Forces, 2003

Leishmaniasis is an arthropod-transmitted zoonotic disease that is caused by protozoa of the genus *Leishmania*.<sup>1,2,3</sup> Leishmania parasites are transmitted through bites of infective female sand flies (*Lutzomyia* species in the Americas and *Phlebotomus* species elsewhere).<sup>4</sup> The disease is endemic in many areas of Asia, Africa, the Middle East, South and Central America, and southern Europe.<sup>1,6</sup>

The clinical expressions of leishmaniasis are highly variable and primarily dependent on the infecting leishmania species and host immune responses.<sup>1,5</sup> Cutaneous, mucosal, and visceral leishmaniasis, the three major clinical forms, are manifestations of skin, naso-oro-pharyngeal mucous membrane, and systemic infections, respectively.<sup>1,5</sup> The courses of cutaneous and mucosal leishmaniasis are characterized by papules that progress to nodules and eventually to ulcers (which are often multiple and can be disfiguring). The manifestations of visceral leishmaniasis (which can be life threatening) include fever, weakness, hepatosplenomegaly, pancytopenia, hyperglobulinemia, and emaciation.<sup>1,3,7,8</sup> Not all infected persons develop signs or symptoms of leishmaniasis; but among those who do, times from infection to first clinical manifestations generally range from a week to many months, with much longer periods (e.g., up to 10 years) for visceral infections.<sup>1,3,9</sup>

U.S. military personnel are exposed to risks of leishmaniasis during training and operations in endemic areas.<sup>2,4,6</sup> Of recent and ongoing concern, leishmaniasis is endemic in many areas of Iraq, Afghanistan, and Kuwait. During the past year, surveillance of female phlebotomine sand flies in areas of Iraq where the U.S. military operated revealed an overall infection rate (among nearly 24,000 female sand flies) of 1.4%.<sup>2</sup>

This report summarizes frequencies, rates, and demographic and military characteristics of U.S. servicemembers who were diagnosed/reported with leishmaniasis during calendar year 2003. The leishmaniasis experience in 2003 is compared to experiences of past years.

**Methods.** We defined three surveillance periods: (1) January-December 2003; (2) January 1999-December

2002; and (3) January 1990-December 1991. We searched records in the Defense Medical Surveillance System (DMSS) to identify all reportable medical events, hospitalizations, and ambulatory visits during the surveillance periods with diagnoses of leishmaniasis (ICD-9-CM: 085.0-085.9). (Hospitalization records were the only records available for the 1990-1991 period.) Only one episode of leishmaniasis per person per year was included. Demographic and military characteristics were ascertained for all affected members of the active and Reserve components of all Services, but incidence rates were calculated for the active components only. Histories of international travel were self-reported. Only one follow-up visit (defined as a hospitalization or ambulatory visit at least one day after a diagnosis) per person per day was included.

**Results.** In 2003, there were 400 incident diagnoses/reports of leishmaniasis among members of the U.S. Armed Forces. All but one of the cases were reported as "cutaneous leishmaniasis." Approximately one-fourth (n=105, 26%) of all cases were Reserve component members (table 1).

The median age of cases was 27 years (range: 18-57 years). Most cases reported service in Iraq and/or Kuwait.

In the active components of the Services, the overall incidence rate of leishmaniasis in 2003 was 20.9 per 100,000 person-years (p-yr). The rate was higher by far in the Army (55.2 per 100,000 p-yr) than the other Services (table 1). The incidence rate was nearly four times higher among men than women; and the rate was higher among servicemembers who were non-Hispanic White than non-Hispanic Black, Hispanic, or "all other" race-ethnicities (table 1, figure 1). During 2003, the rate of diagnosis of leishmaniasis was highest in the autumn and peaked in September (53.2 new diagnoses per 100,000 p-yr) (figure 2).

Among cases (n=235) who had documented medical encounters following their initial diagnoses, the median number of follow-up visits was 10 (range: 2-26 visits). Only one percent of all cases were hospitalized (data not shown).

Not all infected persons develop signs or symptoms of leishmaniasis; but among those who do, times from infection to first clinical manifestations generally range from a week to many months, with much longer periods (e.g., up to 10 years) for visceral infections.

??

Could there be "hidden" or latent cases of Leishmaniasis among other documented disease categories?

??

ABNORMAL BLOOD FINDINGS*	23
CONTACT DERMATITIS*	534
HAIR & FOLLICLE DISEASE*	355
OTH LOCAL SKIN INFECTION*	32
OTH SKIN HYPERTRO/ATROPH*	83
OTHER ABNORMAL FINDINGS*	165
OTHER CELLULITIS/ABSCCESS*	223
OTHER SKIN DISORDERS*	201
SEBACEOUS GLAND DISEASE*	455
SKIN/OTH INTEGUMENT SYMP*	454



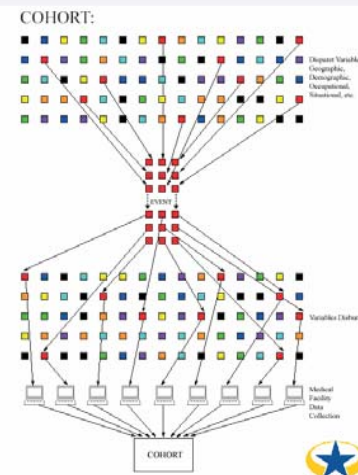
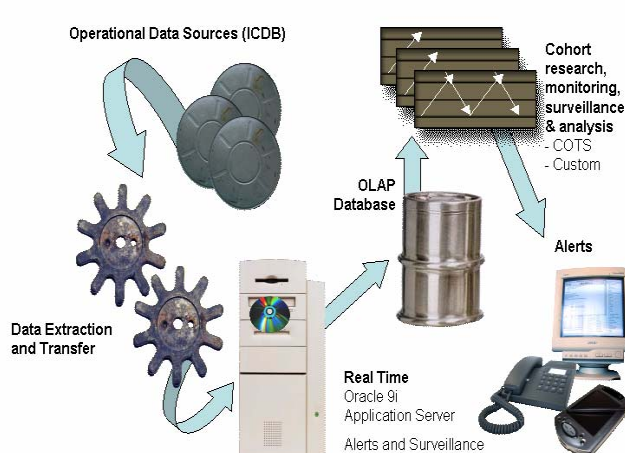
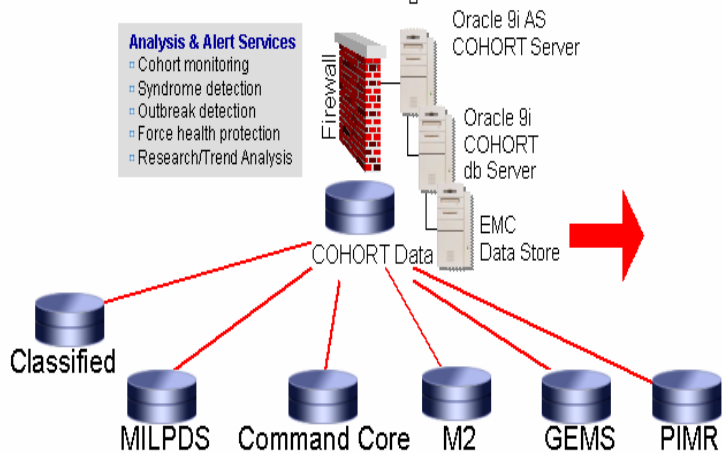
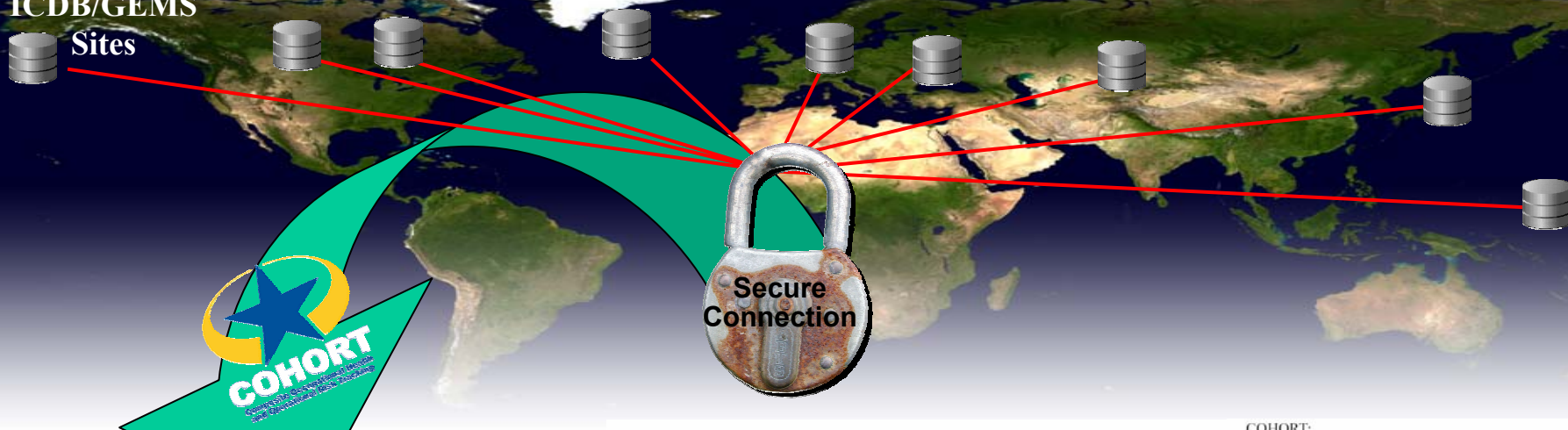
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# COHORT Operations



ICDB/GEMS

Sites



*Integrity - Service - Excellence*

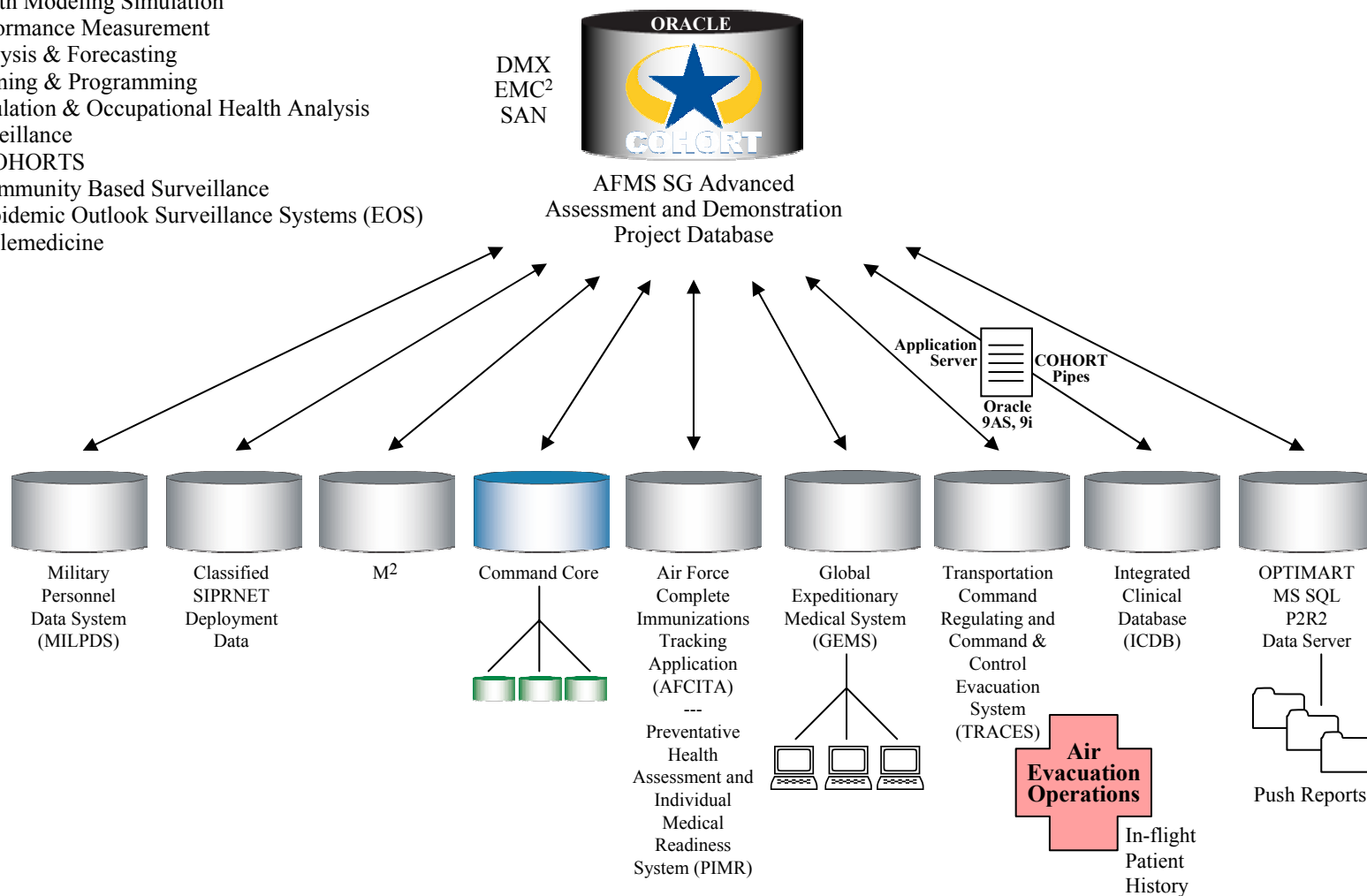


**U.S. AIR FORCE**



## Supported Activities

- Health Modeling Simulation
- Performance Measurement
- Analysis & Forecasting
- Planning & Programming
- Population & Occupational Health Analysis
- Surveillance
  - COHORTS
  - Community Based Surveillance
  - Epidemic Outlook Surveillance Systems (EOS)
  - Telemedicine

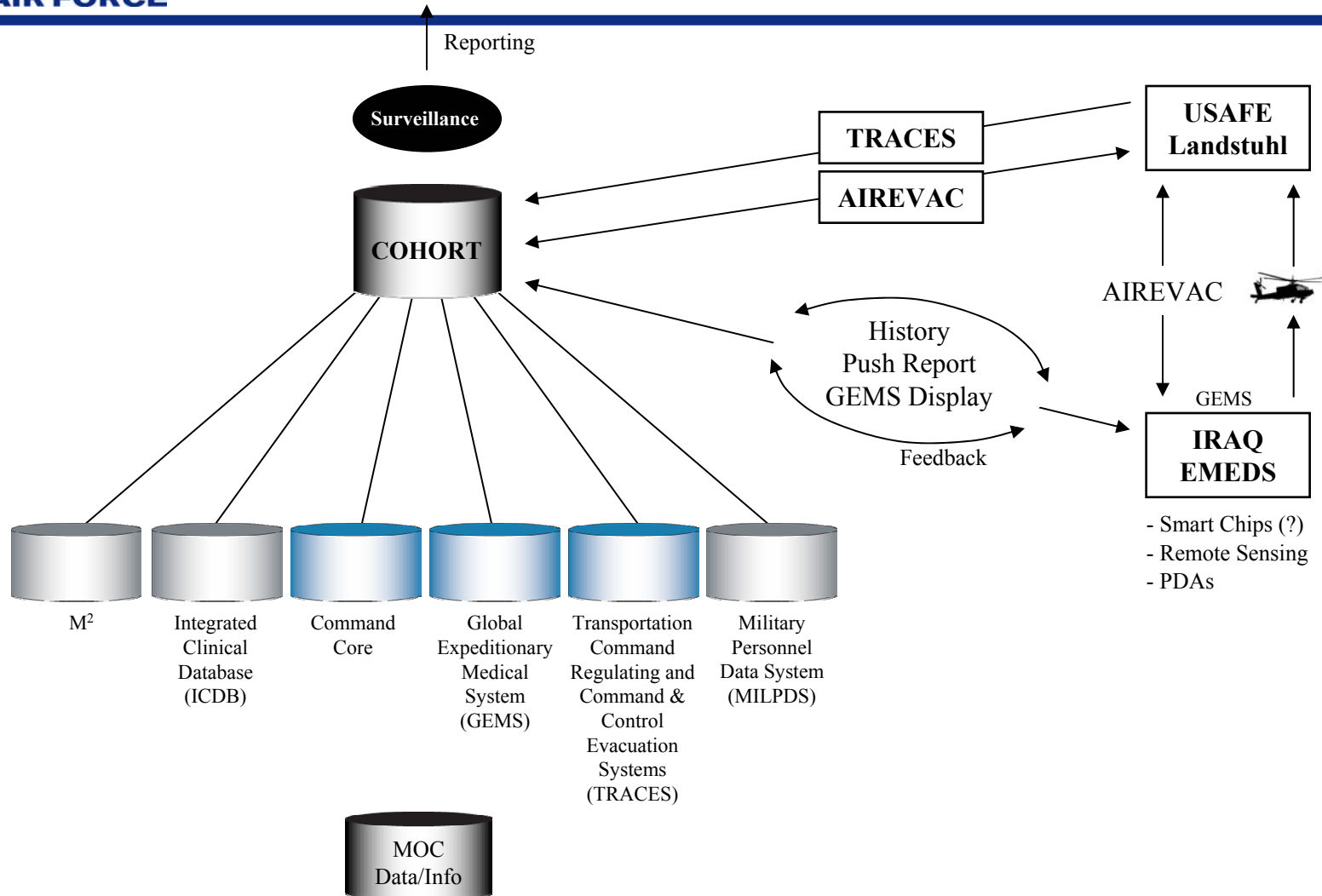


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## Patient Tracking and Clinical Feedback Model (PTCFM)



## Community Based Surveillance



Enable USAF Surgeon General to consolidate, monitor, extract, and analyze **real-time** medical data from all military health care facilities for earlier detection of epidemics, disease trends, and health anomalies

- Pattern Analysis
- Algorithm Development
- Programmed Alerting
- Protocol Standardization







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# Advanced Diagnostics

## EOS Operations and Deliverables



### Respiratory Pathogen Microarray (RPM)

Z-chip from concept to delivery  
(Operational from 07 Jun 2003)  
Common and biowarfare agents  
Iterative design and process  
Delivery, evaluation, and validation

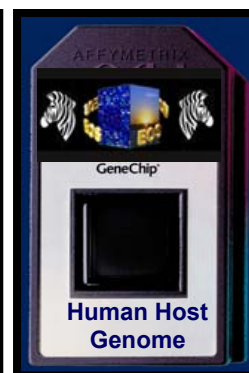
#### Common Pathogens

- Adenovirus
- Influenza
- Coronavirus
- West Nile
- Parainfluenza
- RSV
- Rhinovirus
- Strept. pyogenes
- Chlam. pneumoniae
- Myco. pneumoniae
- Bord. pertussis
- Neiss. meningitidis
- Strept. pneumoniae

#### EOS Pathogen Pie



Up to 500,000  
diagnostic  
tests per chip

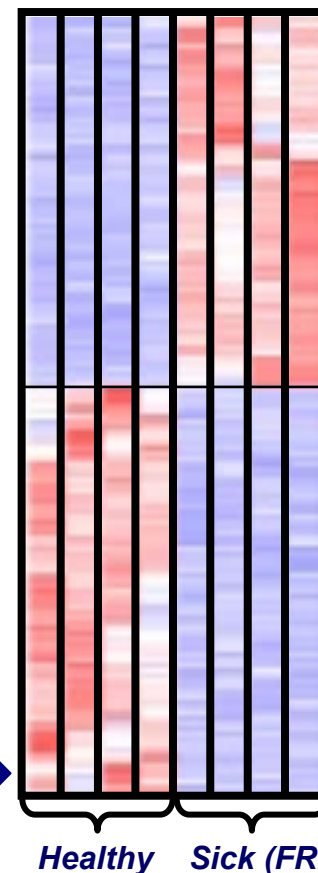


Over 30,000  
human genes  
per test

#### Biowarfare Pathogens

- Smallpox
- Anthrax
- Plague
- Tularemia
- Ebola Virus
- Lassa Fever

### Host Response Gene Expression Profiles



Real Data →



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